

1. A bone anchor comprising:

a rivet which includes a head and an elongate body having proximal and distal ends, the head being mounted on the proximal end of the elongate body;

an expandable sleeve having an inner bore adapted to receive the elongate body of the rivet; and

a washer which floats at an end of the expandable sleeve which first receives the rivet;

wherein, as the rivet is received in the expandable sleeve, the sleeve expands in an interference fit with surrounding bone and the head of the rivet forces the washer into contact with tissue adjacent to the bone, the washer being forced into contact with the tissue at an angle that conforms to an angle of a surface of the bone.

2. A bone anchor according to claim 1, wherein an external surface of the expandable sleeve includes one or more protrusions.

3. A bone anchor according to claim 1, wherein the rivet includes a centerbore which is capable of receiving any of a guide wire, guide pin and K-wire.

4. A bone anchor according to claim 1, further comprising:

a housing which is frangibly coupled to the expandable sleeve via breakable flanges, the housing being adapted to store the rivet prior to insertion of the rivet into the expandable sleeve, and being adapted to affix the bone anchor to a delivery device;

wherein, during deployment of the bone anchor, the head of the rivet breaks the flanges of the housing, thereby freeing the housing from the bone anchor.

5. A bone anchor for attaching tissue to bone, the bone anchor comprising:

a rivet having an elongate body and a head disposed on a proximal end thereof;

an expandable sleeve for insertion into an opening in a bone, the expandable sleeve having an inner bore adapted to receive at least a portion of the elongate body of the rivet; and

a floating washer that is disposed about the expandable sleeve and that floats relative thereto;

wherein motion of the portion of the elongate body of the rivet within the inner bore of the expandable sleeve from a proximal end to a distal end thereof causes (i) the expandable sleeve to expand into an interference fit with the bone, and (ii) secures the floating washer relative to the bone.

6. A bone anchor according to claim 5, wherein the floating washer is secured to the bone at an angle that substantially corresponds to a surface of the bone.

7. An apparatus for deploying a bone anchor into a bone, the bone anchor having a housing which stores a rivet, an expandable sleeve which is frangibly coupled to the housing and into which the rivet is inserted, and a washer which floats relative to the expandable sleeve, the apparatus comprising:

1
10. A bone anchor for attaching tissue to a bone, the bone anchor comprising:

a rivet which includes a head and an elongate body having proximal and distal ends, the head being mounted on the proximal end of the elongate body;

an expandable sleeve which is adapted to move between an unexpanded state and an expanded state, the expandable sleeve having an inner bore which is adapted to receive the elongate body of the rivet distal-end-first so as to cause the expandable sleeve to go from the unexpanded state to the expanded state; and

a washer which surrounds the expandable sleeve and which is capable of both longitudinal motion and of limited angular rotation relative to the head of the rivet, wherein the head of the rivet is adapted to sandwich the washer between the tissue and the head of the rivet when the bone anchor is deployed in the bone so as to hold the tissue substantially in place relative to the bone.

8
11. A bone anchor according to claim 10⁷, wherein the elongate body has a first diameter and, when the expandable sleeve is in an unexpanded state, the inner bore of the expandable sleeve has a second diameter which is less than the first diameter; and

wherein the distal end of the elongate body comprises a tapered tip, the tapered tip having a diameter which gradually decreases to less than the second diameter of the inner bore.

9
12. A bone anchor according to claim 10⁷, wherein an external surface of the expandable sleeve includes one or more protrusions.

10 13. A bone anchor according to claim 10, wherein the rivet includes a centerbore which is capable of receiving any of a guide wire, guide pin and K-wire.

11 14. A bone anchor according to claim 10, further comprising a housing which is removably connected to the expandable sleeve via breakable flanges, the housing being adapted to store the rivet prior to insertion of the rivet into the expandable sleeve;

wherein the head of the rivet is adapted to contact the breakable flanges during deployment of the bone anchor so as to break the breakable flanges, thereby disconnecting the housing from the expandable sleeve and leaving the bone anchor in the bone.

12 15. A bone anchor according to claim 11, wherein the housing has a substantially cylindrical shape and mates to a deployment device used to deploy the bone anchor in bone.

13 16. A bone anchor according to claim 10, wherein the head of the rivet has an undersurface for contacting the washer, the rivet having an undersurface that is any of radiused or angled relative to an axis of the elongate body.

14 17. A bone anchor according to claim 10, wherein the washer has a top surface which interacts with the head of the rivet and which is any of radiused or angled relative to an undersurface of the head of the rivet.

15¹⁸. A bone anchor according to claim ⁷10, wherein, when the bone anchor is deployed in the bone, the rivet holds the washer at an angle relative to the head of the rivet such that the washer is substantially parallel to a surface of the bone.

16¹⁹. A bone anchor according to claim ⁷10, wherein at least one of the rivet, the washer, and the sleeve are bioabsorbable.

17²⁰. A bone anchor according to claim ⁷10, wherein the rivet includes one or more annular ribs.

18²¹. A bone anchor according to claim ⁷10, wherein the sleeve may include one or more slots which runs at least part way along the sleeve.

22. An apparatus for deploying a bone anchor into a bone, the bone anchor having a housing which stores a rivet and a sleeve which receives the rivet from the housing, the apparatus comprising:

a tube having a bore therethrough, the tube being adapted to hold the housing such that the housing is substantially immobile relative to the tube;

a rod which is removably disposed within the bore of the tube, the rod being slidably movable within the tube and within at least a portion of the housing;

wherein the rod is capable of movement between a first location in the tube, a second location in the housing at which the rod forces the rivet out of the housing and into the sleeve, and a third location outside of the tube.

23. An apparatus according to claim 22, wherein the tube includes a proximal end and a distal end, the proximal end of the tube having a tube handle and the distal end of the tube having threading on an inner surface of the tube, the threading being adapted to hold the housing in place;

wherein the rod has a proximal end and a distal end, the proximal end of the rod having a rod knob and the distal end of the rod contacting the rivet in the housing; and

wherein the rod knob is adapted to contact the tube handle during deployment of the bone anchor so as to limit motion of the distal end of the rod relative to the tube.

24. An apparatus according to claim 22, wherein the rod includes a centerbore which is capable of receiving any of a guide wire, a guide pin and a K-wire.

19 25. A method of deploying a bone anchor into a bone using a bone anchor deployment device, where (i) the bone anchor has a housing which stores a rivet and a sleeve which receives the rivet from the housing, the sleeve being connected to the housing by breakable flanges, (ii) the bone anchor deployment device has a tube which holds the housing in place and a rod within the tube which is movable relative to the tube and within the housing held by the tube, and (iii) the rivet, the sleeve, and the rod each have a throughbore, the method comprising the steps of:

positioning a distal end of a K-wire at a location in bone where the anchor is to be deployed;

drilling a hole in the bone at that location;

inserting the sleeve into the hole in the bone by sliding the bone anchor and the bone anchor deployment device over the K-wire via respective throughbores of the sleeve, the rivet, and the rod;

deploying the rivet in the sleeve by applying downward pressure to the rod relative to the tube so as to force the rod into the housing held by the tube, thereby forcing the rivet out of the housing; and

removing the housing from the sleeve while leaving the sleeve and the rivet in the hole in the bone, the removing step removing the housing by retaining a force on the rod and applying a counterforce to the tube so as to cause the breakable flanges to break, thereby disconnecting the housing from the sleeve.

20
26. A method according to claim 19, further comprising the steps of:

removing the deployment device, including the housing of the bone anchor, from the guide wire, guide pin and K-wire

disconnecting the rod from the tube;

sliding the rod back over the K-wire so that the rod is in contact with the head of the rivet; and

applying force to the rod so as to move the rivet still further into the sleeve.

21
27. A method according to claim 20, wherein the rod includes a knob and the pressure is applied to the rod by hammering the knob of the rod.

²²
~~28.~~ A method according to claim ³⁰~~26~~, wherein the bone anchor further comprises a washer which is disposed around the sleeve and which is capable of both longitudinal motion and limited angular rotation relative to the sleeve; and

wherein forcing the rivet still further into the sleeve causes the rivet to set the washer at an angle relative to the head of the rivet such that the washer is substantially parallel to a surface of the bone.

09086508 052898

an outer tube having a bore therethrough and proximal and distal ends, the distal end being adapted to hold the housing of the bone anchor; and

a rod, which is slidably disposed within the bore of the tube, and which is adapted to push the rivet from the housing and into the expandable sleeve so as to force the expandable sleeve to expand into bone;

wherein forcing the rivet into the expandable sleeve causes the washer to be forced into position relative to a surface of the bone and causes the housing to break away from the expandable sleeve.

8. An apparatus according to claim 7, wherein the proximal end of the tube includes a tube handle and the distal end of the tube includes threading on an inner surface of the tube, the threading being adapted to hold the housing in place;

wherein the rod has a proximal end and a distal end, the proximal end of the rod having a knob and the distal end of the rod contacting the rivet in the housing; and

wherein the rod knob is adapted to contact the tube handle during deployment of the bone anchor so as to limit motion of the distal end of the rod relative to the tube.

9. An apparatus according to claim 7, wherein the rod includes a centerbore which is capable of receiving any of a guide wire, guide pin and K-wire.